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PHOTOMETRIC MEASUREMENTS OF ZODIACAL LIGHT AND OF COUNTERGLOW, CORRECTED FOR ATMOSPHERE LUMINESCENCE [see title page]

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By

M. Rene Dumont

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PHOTOMETRIC MEASUREMENTS OF ZODIACAL LIGHT AND OF COUNTERGLOW, CORRECTED FOR ATMOSPHERE LUMINESCENCE *

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Comtes-Rendus de
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by M. René Dumont

13579 A

SUMMARY

The results of measurements concerning the position of the counterglow (gegenschein) and the zodiacal light relative to the ecliptic are presented. The importance of the correction for the night-sky glow is discussed: The isophote lines obtained undergo very serious alterations, depending upon the process employed to evaluate the correction.

AUTHOR

* * *

Photometric measurements of the zodiacal light and of counterglow have been recently published by various authors : Elsasser and Siedentopf [1], Robley [2, 3], Divari and Asaad [4], Blackwell and Ingham [5]. They are about unanimous in presenting the uncertainty of corrections for the atmospheric glow as the mean source of errors.

The photoelectric program pursued since 1961 by means of the 60 cm-telescope of the Haute Provence Observatory according to the observation and reduction method outlined in former Notes [6, 7], allowed me to obtain isophote lines of the zodiacal and counterglow belts, where the correction for the night glow were made point by point, with a maximum of precision compatible with the nature of these phenomena.

* Mesures photométriques de la lumière zodiacale et du gegenschein corrigées de la luminescence atmosphérique.

[redacted]

This method consisted in selecting a spectral region where the atmospheric emissions amount almost exclusively to the continuum (the 4 900 – 5 500 Å window offering to that effect the best possibilities) and in utilizing for the continuum intensity criterion that of the green line 5 577 A, recognized by Barbier [8, 9] as varying in close correlation with the former.

The general expression of the extraterrestrial luminescence given in the Note [6] served for the reduction of observations of the counterglow. As to the observation of belts, it was made at constant zenithal distance $z = 75^{\circ}$, precaution improving the security of the reductions and simplifying the general formula, which then becomes

$$L_{ext} = k[I - mQ_{5577} - C],$$

where I is the luminance observed in the 4 900 – 5 500 Å window, Q_{5577} is the luminance of the green line at the same point and at the same moment of time, k, m and C being three constants, whose determination is based upon the standardization discussed in the Note [7].

The conclusions of these measurements, spread over two years, with some thirty good nights totalling about 1400 observation points, can be summarized as follows : The axis of the morning belt (autumn observations) is slightly shifted to the south of the ecliptic; the axis of the evening belt (winter observations) is slightly shifted to the north of the ecliptic. The order of magnitude of this shift, measuremed over the median parts of the chordes of isophotes drawn perpendicularly to the ecliptic, is of 1° at 50° of the Sun. In the remote zodiacal band, i. e. beyond 90° from the Sun, it reaches 2 to 3°, with the exception for the anti-solar region : Indeed, although the general shape of the counterglow isophotes often shows a westward elongation, the most brillant point (obviously in extraterrestrial light) was always found in coincidence with the anti-Sun.

As an example, Fig. 1 below shows the counteglow isophotes of 28 – 29 September 1962. The numbers represent the extraterrestrial luminances referred to the standard unit (star of tenth magnitude V of the type G 2 V, per degree-square). This example was chosen to emphasize the importance of corrections for atmosphere luminescence. The isophotes of Fig. 1 are obtained taking into account the local and instantaneous intensities of the green line, and consequently of the green atmospheric continuum, However, at about the middle of that night, the value of Q_{5577} brought to the zenith, say Q^n_{5577}, dropped from 300 to 120 rayleighs between the first and the last of the 63 points effected during glow culmination. The question arises therefore, what would become of these isophotes if a "mean" intensity was attributed to the atmospheric component, thus independent of the particular values of Q_{5577}, but depending only on z. One may then adopt for that standard intensity the mean zenithal one $Q^n_{5577} = 220$ Rayleighs of the observations' whole.

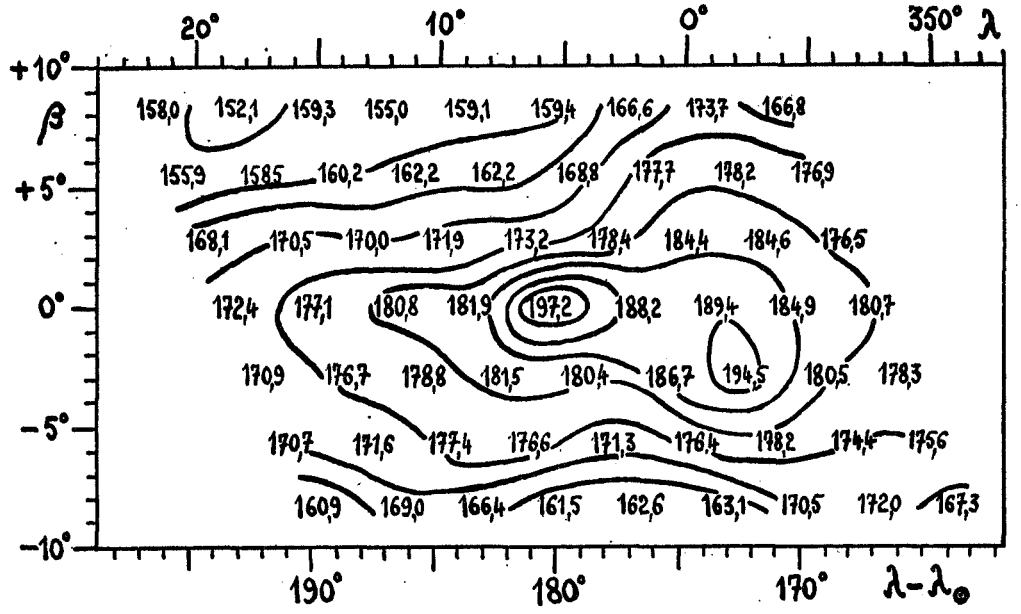

Fig. 1.

One is thus reduced to the hypothesis admitted by the majority of zodiacal light observers, that the shifts of the terrestrial component relative to a stable Van Rhijn distribution in the course of the night are negligible.

Fig. 2 shows the isophotes that would result from this simplification. It goes without saying that the isophotoes that would be obtained by neglecting completely the atmospheric component are still further different from the preceding ones. One may visualize how the atmospheric continuum, which is intense during the photometry of the western half of the glow, then decreasing during that of the eastern half, manages to completely decenter the apparent contour of the counterglow.

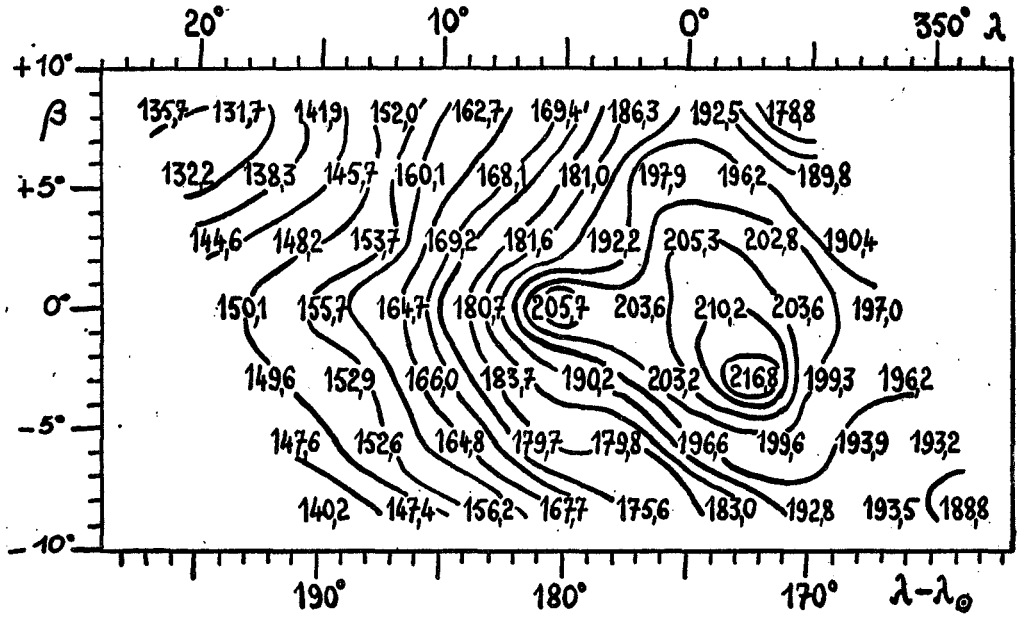

Fig. 2.

The antisolar point at the center presents itself in the simplified reduction as a secondary maximum relative to a main peak, from which it is distant by 8°. In the complete reduction the antisolar point becomes again the principal maximum, and if the other peak has not disappeared, it is rather likely that it is only due to a residue of reduction and to atmospheric transparency fluctuations, and its real existence is quite uncertain.

Doubtless, the vicissitudes of the green line are not always that well marked. It is just as likely that in the zodiacal belts the extraterrestrial luminance is by 1.5 to 4 times stronger than in the

counterglow, so that the intensity variations of the night sky glow are then relatively less bothering. In fact, they are nearly that much upsetting since at the zenithal distance of 75° the obliquity under which the emission layer is seen, multiplies by 1.9 the luminance of this layer relative to zenithal distances of the counterglow passing at meridian of our latitudes ($z \lesssim 40°$). A double reduction of belt observations, analogus to that presented above, leads to differences which do not affect the general shape of the glow, but are quite sufficient to confuse the weak dissymmetries which the latter offers relative to the ecliptic.

In the photometric problem of the zodiacal light and counterglow, and more particularly if one searches for the positions and the shapes of these glows, the advantages in having each marking corrected individually for the night-sky glow (being supported by the deviations given by an auxiliary filter at 5577 Å and the Barbier correlations) do not appear to me as leaving any doubt.

**** THE END ****

Translated by ANDRE L. BRICHANT
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February 27, 1964.

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